INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

MECHANICAL ENGINEERING

TUTORIAL QUESTION BANK

Course Title	FINITE ELEMENT MODELLING				
Course Code	AME014				
Programme	B. Tech				
Semester	VI	ME			
Course Type	Core				
Regulation	**IARE - R16**				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Chief Coordinator	Ms. V. Prasanna, Assistant Professor, Mechanical Engineering				
Course Faculty	Mr. B.D.Y. Sunil, Associate Professor, Mechanical Engineering				

COURSE OBJECTIVES:

The course should enable the students to:

	Description
I	Select and apply numerical methods to solve engineering problems
II	Discretize the given continuum and problem formulation using constitutive relations.
III	Apply FEM techniques to solve engineering problems (both vector and scalar) involving various fields for design,
IV	Understand to refine the approximate solution by spending more computational effort by using higher order interpolation continuities.

COURSE OUTCOMES (COs):

COs	**Course Outcome**
CO 1	Understand characteristic features of robots and usage of different grippers for industrial applications.

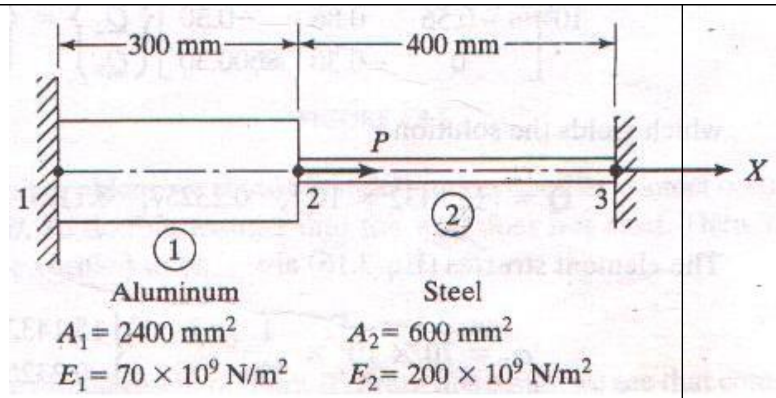
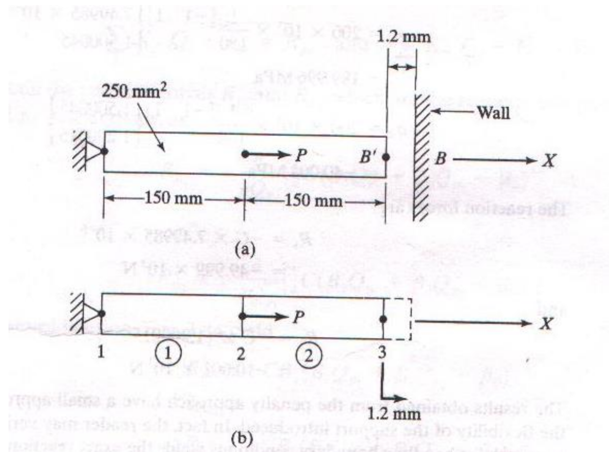
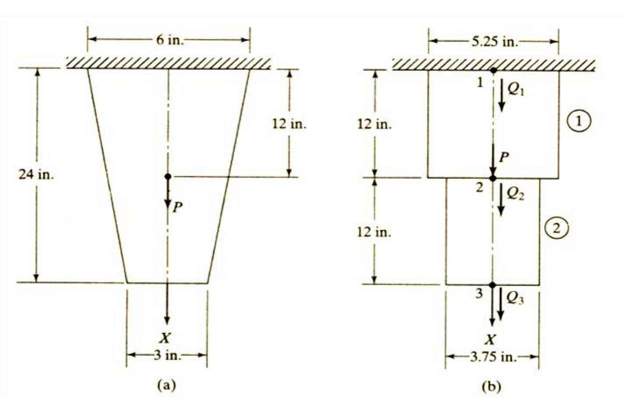
CO 2	Understand direct and inverse kinematics of robot structure.
CO 3	Illustrate Differential Kinematics of planar and spherical manipulators.
CO 4	Understand classification of robot actuators and trajectory planning.
CO 5	Remember material handling and applications in manufacturing.

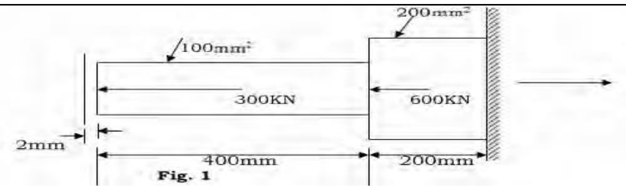
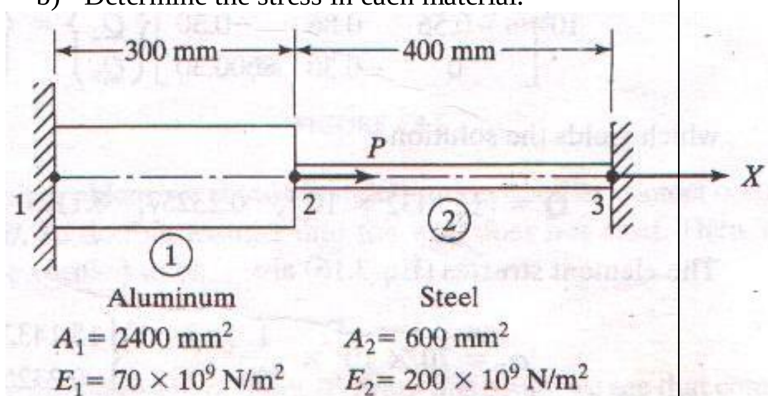
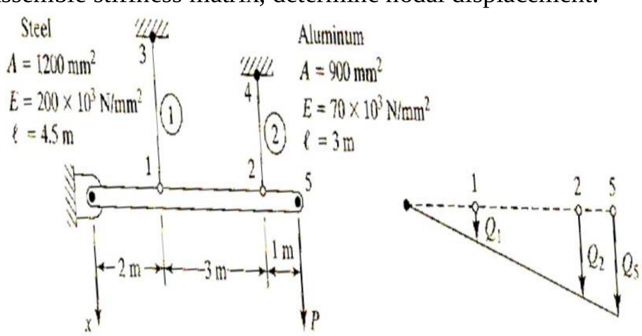
COURSE LEARNING OUTCOMES (CLOs)

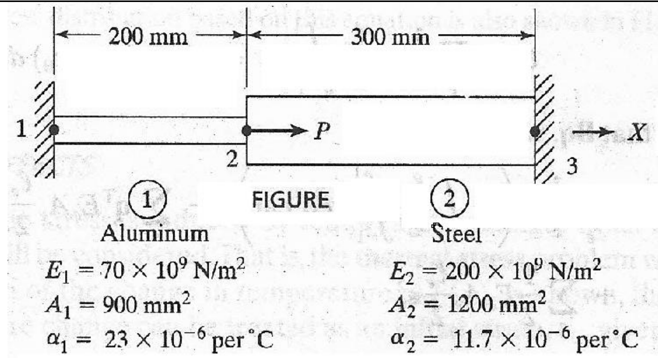
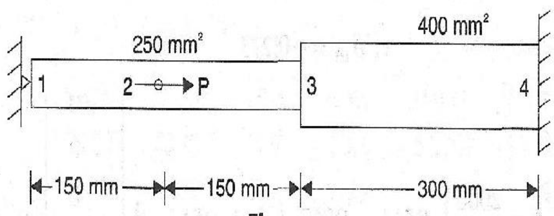
Students, who complete the course, will be able to demonstrate the ability to do the following:

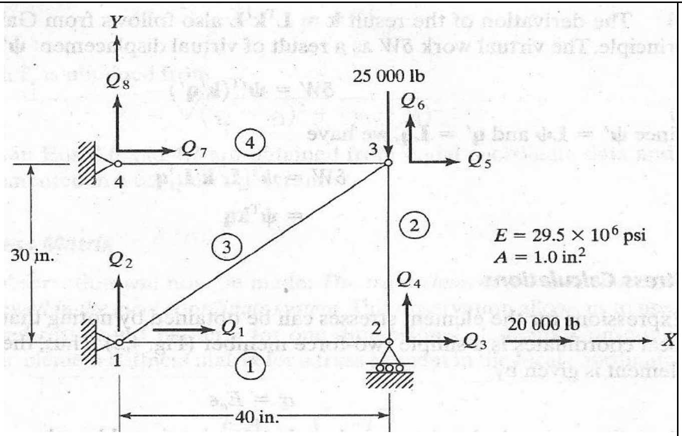
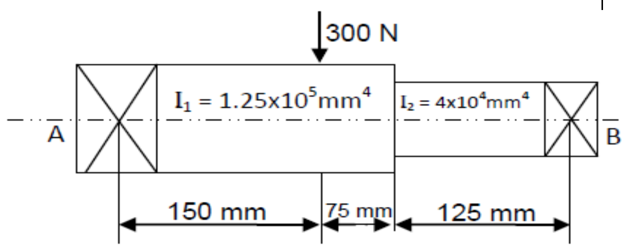
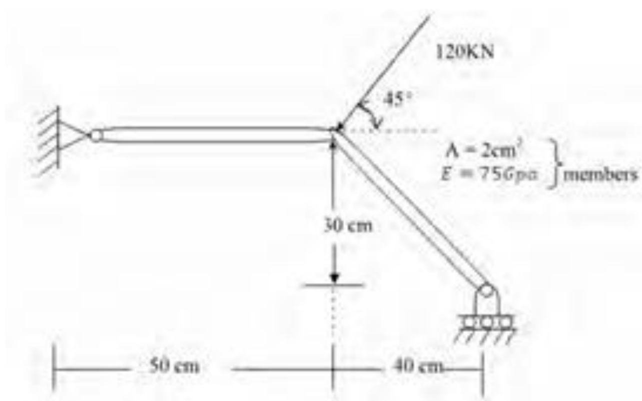
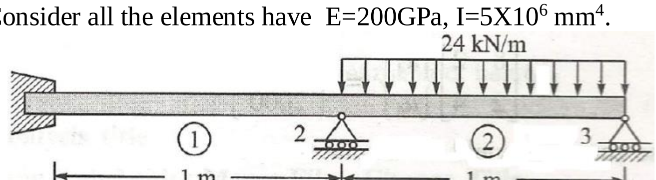
AME014.01	Understand the numerical methods and development of mathematical models for physical system
AME014.02	Identify mathematical model for solution of common engineering problems in the field of aeronautical, mechanical and civil
AME014.03	Understand the concepts of shape functions for one dimensional and quadratic elements, stiffness matrix and boundary conditions
AME014.04	Remember the steps involved in finite element methods while solving the model of physical problem
AME014.05	Apply numerical methods for solving one dimensional bar problems
AME014.06	Identify the mathematical models for two-dimensional, three-dimensional truss and beam elements.
AME014.07	Solve the equations of truss and beam elements
AME014.08	Calculate stress strain and strain energy for common engineering problems
AME014.09	Derive element matrix by different methods by applying basic laws in mechanics and integration by parts
AME014.10	Demonstrate the ability to evaluate and interpret FEA analysis results for design and development purposes
AME014.11	Formulate simple and complex problems into finite elements and solve structural and thermal problems
AME014.12	Derive the element stiffness matrices for triangular elements and axi- symmetric solids and estimate the load vector and stresses.
AME014.13	Understand the concepts of steady state heat transfer analysis for one dimensional slab, fin and thin plate.
AME014.14	Understand the concepts of mass and spring system and derive the equations for various structural problems
AME014.15	Calculate the mass matrices; Eigen values Eigen vectors and natural frequency for dynamic problems.
AME014.16	Model multi-dimensional structural and heat transfer problems by using automatic and fully automatic software such as ANSYS, NISA, NASTRAN.

UNIT - I				
INTRODUCTION TO FEM				
PART - A (SHORT ANSWER QUESTIONS)				
S No	**QUESTIONS**	**Blooms taxonomy level**	**Course Outcomes**	**Course Learning Outcomes**
1	Explain finite element methods	Remember	CO 1	AME014.01
2	What is degree of freedom and boundary conditions	Understand	CO 1	AME014.02
3	Give the expression for shape functions of a linear element.	Understand	CO 1	AME014.03
4	Specify some applications of finite element methods	Remember	CO 1	AME014.01
5	Name the different methods used for solving problems in FEM	Remember	CO 1	AME014.01
6	Draw the shape functions of quadratic element and linear element	Understand	CO 1	AME014.03
7	What is the element stiffness matrix for a quadratic element	Understand	CO 1	AME014.03
8	Write the expressions for stress strain relationship for 2D elastic problems	Understand	CO 1	AME014.02
9	What is the stiffness matrix for one dimensional element?	Remember	CO 1	AME014.05
10	Discuss different types of elements	Remember	CO 1	AME014.05
PART - B (LONG ANSWER QUESTIONS)				
1	Explain the concept of FEM briefly and outline the steps involved in FEM	Remember	CO 1	AME014.01
2	What is the difference between the plane stress and plane strain condition?	Understand	CO 1	AME014.04
3	Define principle of virtual work. Describe the FEM formulation for 1D bar element.	Remember	CO 1	AME014.02
4	Derive element stiffness matrix and load vector for linear element using potential energy approach.	Understand	CO 1	AME014.03
5	Describe the penalty approach for multipoint constraint with an example.	Understand	CO 1	AME014.02
6	Derive element stiffness matrix and load vector for quadratic element	Remember	CO 1	AME014.03
7	Derive element stiffness matrix and load vector for quadratic element using potential energy approach.	Remember	CO 1	AME014.03
8	Explain the equilibrium state of the system, when the system is subjected to different types of loads and explain the stress and equilibrium relations	Understand	CO 1	AME014.05
9	Derive stress strain relationships for 2D elastic problems.	Remember	CO 1	AME014.02
10	What are the advantages disadvantages and applications of FEM	Remember	CO 1	AME014.01
PART - C (PROBLEM SOLVING AND CRITICAL THINKING QUESTIONS)				
1	Consider the following figure. An axial load P=200 KN is applied as shown a) Determine the nodal displacements. b) Determine the stress in each material. c) Determine the reaction forces.	Understand	CO 1	AME014.05

<table>
<tr><td></td><td>
</td><td></td><td></td><td></td></tr>
<tr><td>2</td><td>In the fig. given below, a load P=60 KN is applied as shown. Determine the displacement field, stress and support reactions in the body. Take E as 20 GPa

</td><td>Understand</td><td>CO 1</td><td>AME014.05</td></tr>
<tr><td>3</td><td>Consider the thin (steel) plate in Fig. The plate has a uniform thickness t =10 mm, Young’s modulus E = 100Gpa, and weight density=78500N/m3. In addition to its self-weight, the plate is subjected to a point load P = 60N at its midpoint.
a) Write down expressions for the element stiffness matrices and element body force vectors
b) Deteremine the stresses in each element and reaction force at the support.
Consider 1in= 1cm for SI units

</td><td>Understand</td><td>CO 1</td><td>AME014.05</td></tr>
<tr><td>4</td><td>Consider the bar shown in figure loaded as shown in Determine the
a) nodal displacements
b) element stresses and support reactions. E = 200 GPa</td><td>Understand</td><td>CO 1</td><td>AME014.05</td></tr>
</table>

	 Fig. 1			
5	A bar is subjected to an axial force is divided into a number of quadratic elements. For a particular element the nodes 1, 3, 2 are located at 15mm, 18mmand 21mmrespectivelly from origin. If the axial displacements of the three nodes are given by u_1=0.00015mm, u_3=0.0033and u_2=0.00024mm. Determine the following a) shape function b) variation of the displacement u(x) in the element c) axial stain in the element	Understand	CO 1	AME014.05
6	Consider the following fig. An axial load P=200 KN is applied as shown. Using an elimination approach, do the following a) Determine the nodal displacements. b) Determine the stress in each material. 	Understand	CO 1	AME014.05
7	Consider the structure shown in Fig. A rigid bar of negligible mass, pinned at one end, is supported by a steel rod and an aluminum rod. A load P = 30 kN. N is applied as shown. Assemble stiffness matrix, determine nodal displacement. 	Understand	CO 1	AME014.05
8	An axial load P=300X10^3N is applied at 20^0 C to the rod as shown in Figure below. The temperature is the raised to 60^0 C. a) Assemble the K and F matrices. b) Determine the nodal displacements and stresses.	Remember	CO 1	AME014.08

				
9	Determine the nodal displacement, Element stresses for axially loaded bar as shown in the fig. below  Fig.	Understand	CO 1	AME014.10
	UNIT - II			
	ANALYSIS OF TRUSSES AND BEAMS			
	PART - A (SHORT ANSWER QUESTIONS)			
1	Represent the truss in local coordinate system.	Understand	CO 2	AME014.06
2	Write the transformation matrix of a truss.	Remember	CO 2	AME014.06
3	Write the stress equation for truss elements	Remember	CO 2	AME014.07
4	What is the expression for strain energy in a truss element	Understand	CO 2	AME014.08
5	Draw Hermite shape functions.	Remember	CO 2	AME014.06
6	Write the expression for element stiffness matrix of a beam	Remember	CO 2	AME014.07
7	What is the expression for a shear force of a beam?	Remember	CO 2	AME014.06
8	What is the expression for a load vector of a beam	Understand	CO 2	AME014.07
9	What is the expression for a bending moment of a beam?	Remember	CO 2	AME014.06
10	Write the stiffness matrix for a beam.	Understand	CO 2	AME014.07
	PART - B (LONG ANSWER QUESTIONS)			
1	Derive the shape functions for beams and draw the shape functions	Understand	CO 2	AME014.07
2	Derive the stiffness matrix for beam elements.	Understand	CO 2	AME014.07
3	Derive the stiffness matrix for two-dimensional truss element.	Remember	CO 2	AME014.07
4	Assemble the global stiffness matrix and nodal displacement-for the fig. shown below Understand the problem by using SI units only. Take 1lb = 4.44N 1 in^2 = 645.16 mm^{2}1psi = 6.89 KP 1in = 25.4mm	Understand	CO 2	AME014.08

				
5	Find the deflection at the load and the slopes at the ends for the shaft shown in figure. Consider the shaft to be simply supported bearings A and B. Solve by FEM technique. Take E = 200 Gpa 	Understand	CO 2	AME014.08
6	For the truss shown in figure. Determine the a) displacements and b)stresses in the bars 	Understand	CO 2	AME014.08
7	For the beam shown in Figure below, determine the following: a) Slopes at nodes 2 and 3. b) Vertical deflection at the mid-point of the distributed load. Consider all the elements have E=200GPa, I=5X10^6 mm^4.  **Figure** beam with distributed load	Understand	CO 2	AME014.10
8	A beam fixed at one end and supported by a roller at the other	Understand	CO 2	AME014.10

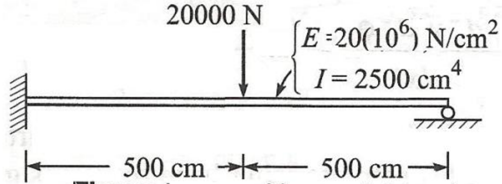
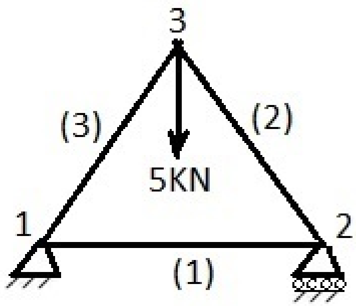
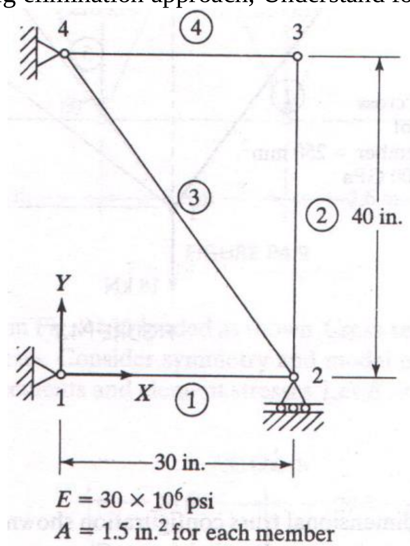
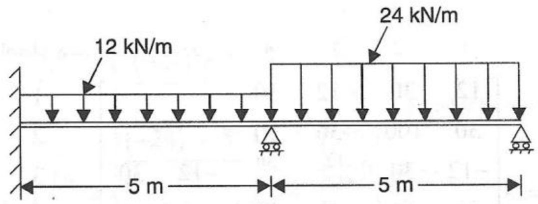
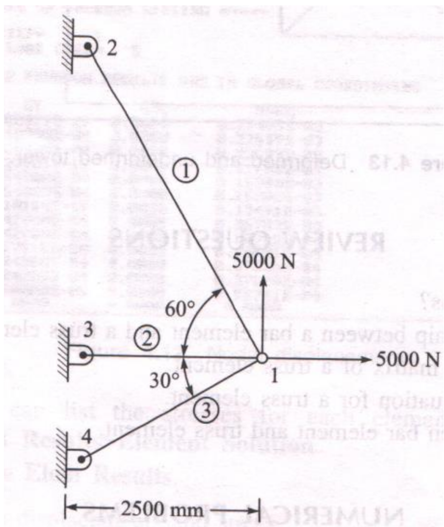
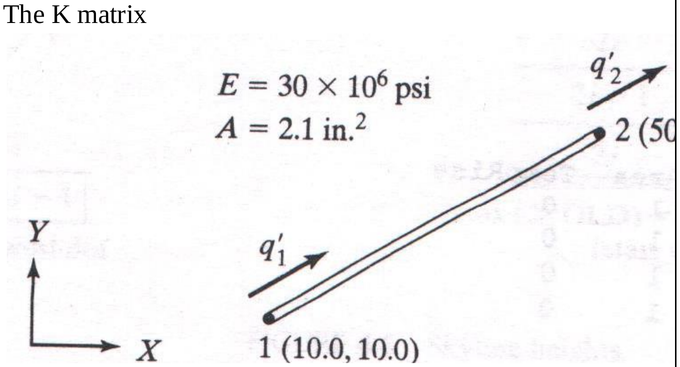
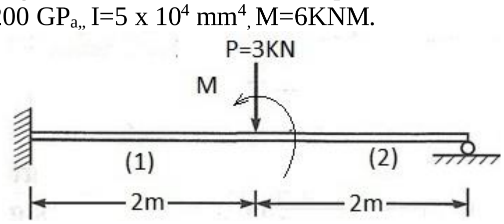
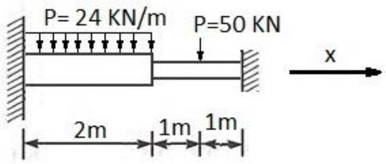
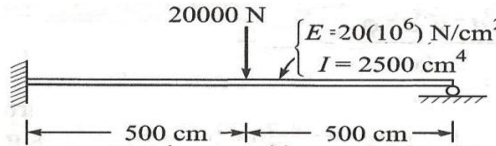
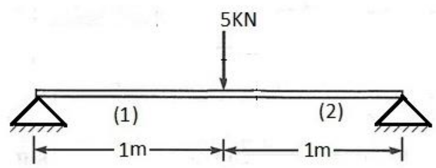
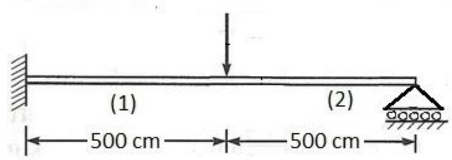
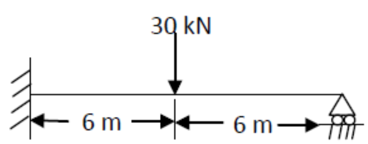
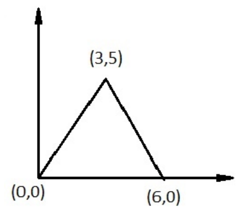
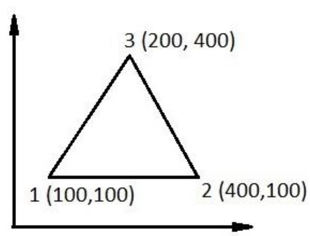
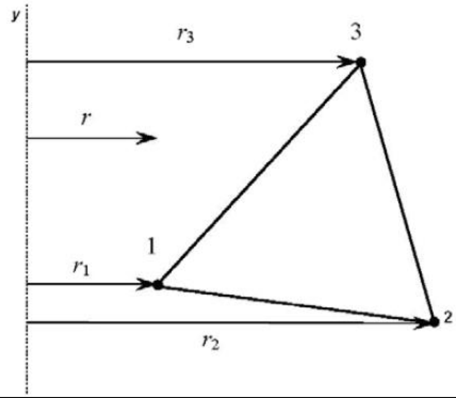
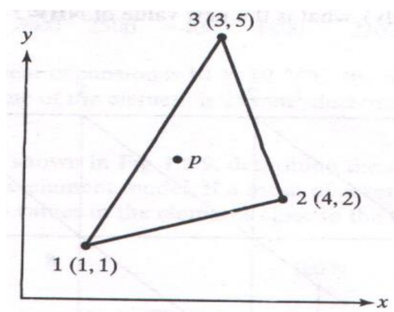
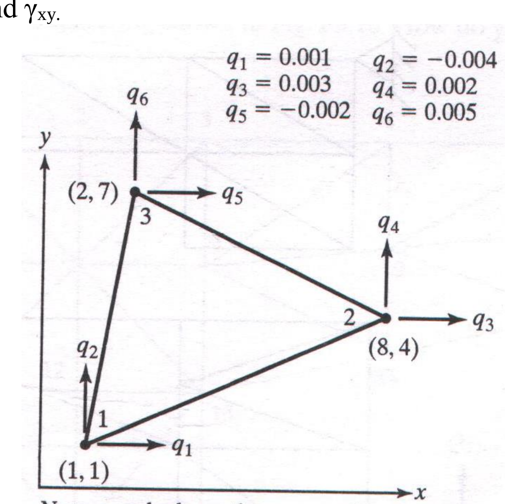
<table>
<tr><td></td><td>end, has a 20kN concentrated load applied at the centre of the span (Figure below). Calculate the deflection under the load and construct the shear force and bending moment diagrams for the beam


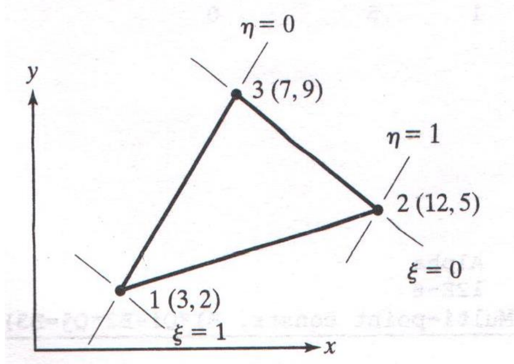
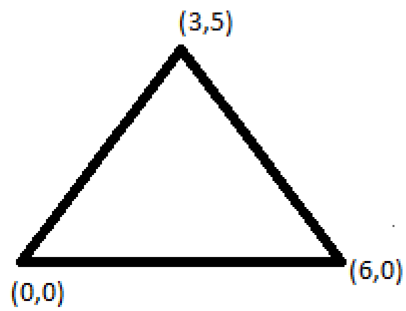
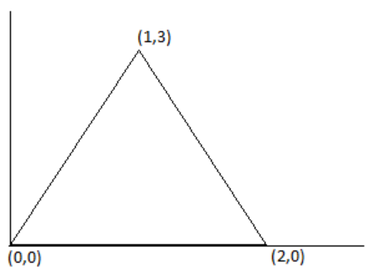
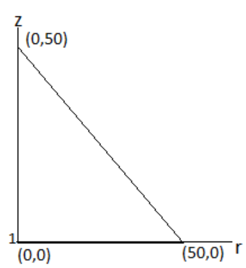
Figure beam with a point load</td><td></td><td></td><td></td></tr>
<tr><td>9</td><td>Derive the Stiffness matrix for a 3D truss Element.</td><td>Remember</td><td>CO 2</td><td>AME014.09</td></tr>
<tr><td>10</td><td>Determine Nodal displacements and Element stresses in the truss shown in figure. E=80GPa
<table>
<tr><th>Element</th><th>Area mm^2</th><th>Length mm</th></tr>
<tr><td>1</td><td>600</td><td>500</td></tr>
<tr><td>2</td><td>600</td><td>600</td></tr>
<tr><td>3</td><td>600</td><td>500</td></tr>
</table>

</td><td>Understand</td><td>CO 2</td><td>AME014.08</td></tr>
<tr><td></td><td colspan="4">PART – C (PROBLEM SOLVING AND CRITICAL THINKING)</td></tr>
<tr><td>1</td><td>For the truss given below, a horizontal load of P = 4000 lb is applied in the x-direction at node 2.
a) Write down the element stiffness matrix k for each element.
b) Assemble the K matrix
c) Using elimination approach, Understand for Q

</td><td>Understand</td><td>CO 2</td><td>AME014.10</td></tr>
<tr><td>2</td><td>Apply the beam shown in Figure below by finite element method and determine the end reactions. Also determine the</td><td>Understand</td><td>CO 2</td><td>AME014.11</td></tr>
</table>

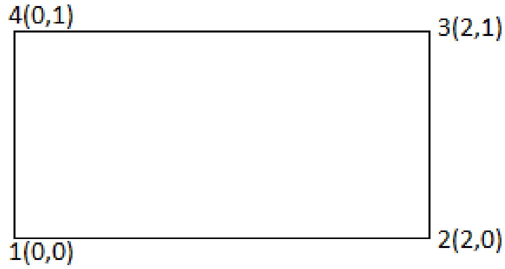
	deflections at mid spans given $E=2X10^5 N/mm^2$, and $I=5X10^6$ mm^4.  			
3	For the truss shown in fig, for the horizontal and vertical components of displacement at node 1 and determine the stress in each element. All elements have A = 500 mm^2 and E = 70 GPa.  	Understand	CO 2	AME014.11
4	For the truss element shown below, if q = $[1.5,1.0,2.1,4.3]^T x10^{-2}$ in., determine the following: a) The vector q' b) The stress in the element The K matrix  	Understand	CO 2	AME014.11
5	Determine the nodal displacements and slopes for the beam shown in fig. find the moment at the midpoint of element. Take E=200 GP_a, I=5 x 10^4 mm^4, M=6KNM.  	Understand	CO 2	AME014.11
6	Determine the deflection and slope under the point load for the beam shown in fig given. E=200 GP_a, I= 4 x $10^{-6} m^4$, I_2=2 x $10^{-6} m^4$.	Understand	CO 2	AME014.11

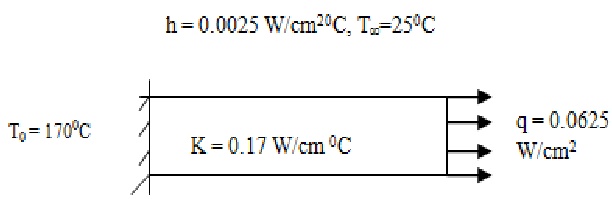
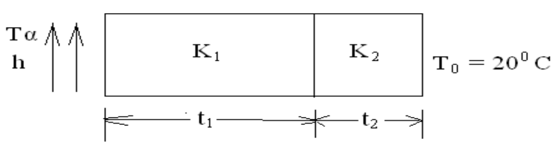
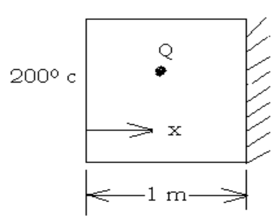
				
7	A beam fixed at one end and supported by a roller at the other end, has a 20kN concentrated load applied at the centre of the span (Figure below). Calculate the deflection under the load and construct the shear force and bending moment diagrams for the beam.  beam with a point load	Understand	CO 2	AME014.11
8	Determine the nodal displacements and slopes at the position of one-fourth distance from the support of shaft: Take E=200 GP$_{a,,}$ I=6 x 10^4mm$^{4.}$ The shaft is simply supported at A and B. 	Understand	CO 2	AME014.11
9	A beam fixed at one end and supported by a roller at the end, has a 20KN concentrated load applied at the centre of the span, as shown in fig. calculate the deflection under the load and construct shear force and bending moment diagram for the beam. Take E = 20 x 10^6 N/c,^{2,} I=2500 cm$^{4.}$ 	Understand	CO 2	AME014.11
10	Calculate the deflection under load, shear force and bending moment at mid span and reactions at supports for the beam shown in figure. Take E=200 GPa and I= 24×10^{-6} m^4. 	Understand	CO 2	AME014.08
	UNIT-III			
	2-D ANALYSIS			
	PART - A (SHORT ANSWER QUESTIONS)			
1	What is a CST element with example?	Remember	CO 3	AME014.12
2	List any four two dimensional elements	Remember	CO 3	AME014.09
3	Represent the node numbering of Constant strain triangle element.	Remember	CO 3	AME014.08
4	What is LST element with example?	Remember	CO 3	AME014.10

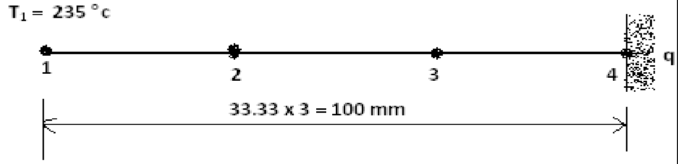
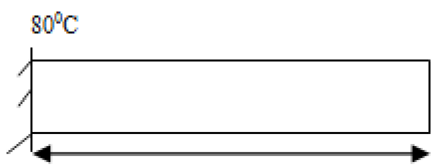
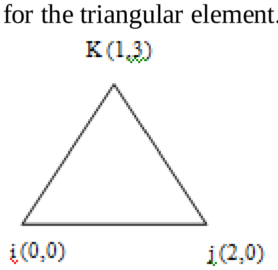
5	What is the condition for number of unknown polynomial coefficients of a 2-D element	Understand	CO 3	AME014.12
6	Define plane stress and plane strain	Understand	CO 3	AME014.08
7	Write the expression of traction force for four node quadrilateral element.	Understand	CO 3	AME014.12
8	Represent the node numbering of Linear strain triangle element.	Understand	CO 3	AME014.12
9	What is meant by axisymmetric solid?	Understand	CO 3	AME014.08
10	Differentiate between linear and nonlinear elements.	Understand	CO 3	AME014.09
11	What is isoparametric representation	Understand	CO 3	AME014.10
	PART – B (LONG ANSWER QUESTIONS)			
1	Derive the strain displacement matrix for triangular element	Understand	CO 3	AME014.12
2	Derive the Jacobian of transformation	Understand	CO 3	AME014.12
3	Derive force terms for constant strain triangle.	Remember	CO 3	AME014.08
4	Apply the element stiffness matrix for the triangular element shown in figure under plane strain condition. Assume the following values. E=200 GP_a, μ=0.25, t=1 mm. 	Understand	CO 3	AME014.12
5	Determine the nodal displacements and element stresses for the two-dimensional loaded plate as shown in figure. Assume plane stress conditions. Body force may be neglected in comparison to the external forces. Take E=210 GPa, μ=0.25; thickness = 10mm. 	Understand	CO 3	AME014.10
6	Determine the shape functions for a 8 node quadratic quadrilateral element (boundary noded).	Understand	CO 3	AME014.12
7	Derive the shape function and strain displacement matrices for triangular element of revolving body	Understand	CO 3	AME014.09
8	Derive the element stiffness matrix for four noded quadrilateral element	Remember	CO 3	AME014.08
9	Evaluate the integral I=$\int$	Understand	CO 3	AME014.10
10	Evaluate the axisymmetric stiffness matrix ***K*** of the triangular element shown in the figure. Consider the coordinates of nodes as 1 (2, 1), 2 (4, 0), and 3 (3, 2). Also assume E = 2.6 GPa and ν = 0.2.	Understand	CO 3	AME014.12

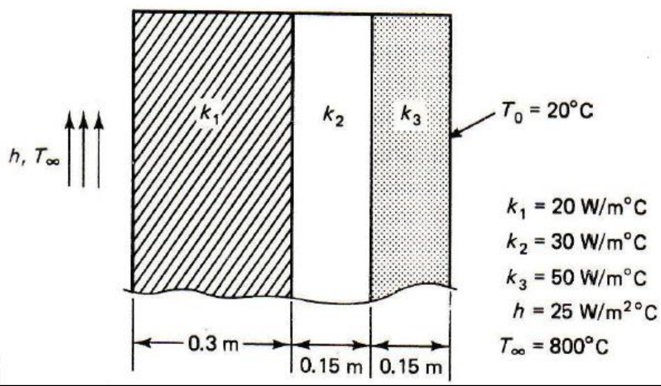
				
11	Derive the shape functions, strain-displacement matrix, stiffness matrix and nodal load vectors for a constant strain triangular element	Understand	CO 3	AME014.09
12	Derive the strain-displacement matrix, stiffness matrix and nodal load vectors for a linear strain triangular element.	Remember	CO 3	AME014.08
	PART – C (PROBLEM SOLVING AND CRITICAL THINKING)			
1	For the point P located inside the triangle, the shape functions N_1 and N_2 are 0.15 and 0.25, respectively. Determine the x and y coordinate of P 	Understand	CO 3	AME014.10
2	For the triangular element shown in fig, obtain strain-displacement relation matrix B and determine the strains ε_x, ε_y and γ_{xy}.  *Note:* **q** and **x** have the same units.	Understand	CO 3	AME014.12
3	Determine the Jacobian for the (x, y) – (ξ, η) transformation for the element shown in fig, also find the area of the triangle.	Understand	CO 3	AME014.09

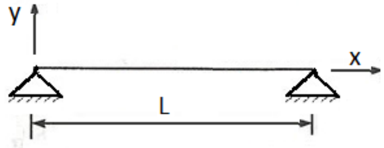
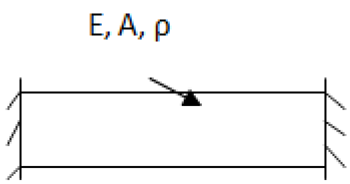
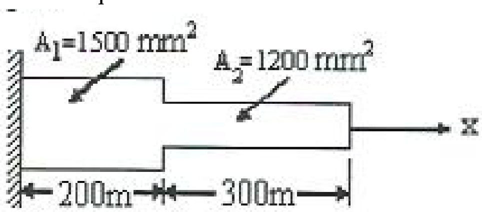
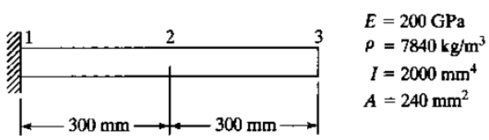
				
4	For the plane stress element shown in figure, determine the stiffness matrix. Assume E=200 GPa and μ=0.3. Thickness =10 mm. 	Understand	CO 3	AME014.08
5	Calculate the element stiffness matrix and thermal force vector for the plane stress element shown in figure. The element experiences a rise of 10^0C.E=15×10^4 N/mm^2, t=5 mm, μ=0.25, α=6×10^{-6} 	Understand	CO 3	AME014.10
6	For the axisymmetric element shown in figure. Determine the stiffness matrix. Let E=2.1×10^5 MN/m^2 and μ=0.25. The coordinates are in mm. 	Understand	CO 3	AME014.12
7	The (x,y) co-ordinates of nodes i, j and k of an axisymmetric triangular element are given by (3.4), (6,5) and (5,8) cm respectively. The element displacement (in cm) vector is given	Remember	CO 3	AME014.08

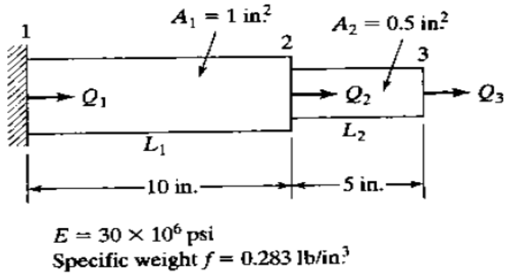
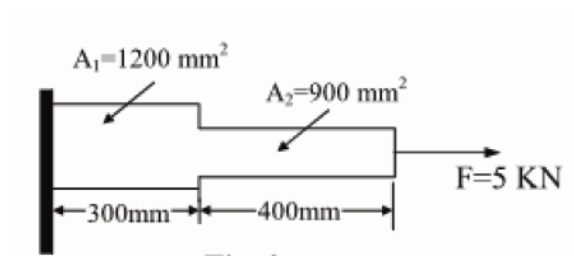
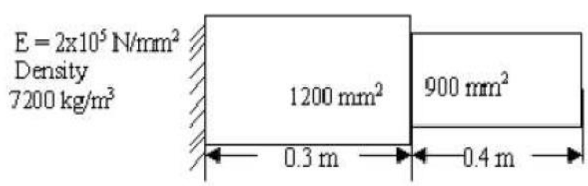
	as q= [0.002, 0.001, 0.004, -0.003, 0.007]^T. Determine the element strains			
8	Apply the integral I=$\int\int(3x^3+2xy+7y^3)$dx dy in the limits of -1 to +1 using gauss quadrature numerical integration and verify with exact solution	Understand	CO 3	AME014.09
9	A four noded rectangular element is shown in figure. Determine Jacobian matrix, Strain displacement matrix and element stresses. Take E=2×10^5 N/mm^2, μ=0.5, u=[0, 0, 0.005, 0.008, 0.008, 0,0]^T, $\varepsilon= 0, \eta=0$ 	Understand	CO 3	AME014.12
10	The Cartesian global coordinates of the corner nodes of an isoparametric quadrilateral element are given by (1,0), (2,0), (2.5, 1.5) and (1.5,1). Find its Jacobian matrix.	Understand	CO 3	AME014.12
	UNIT-IV			
	STEADY STATE HEAT TRANSFER ANALYSIS			
	PART – A (SHORT ANSWER QUESTIONS)			
1	Define steady state heat transfer	Understand	CO 4	AME014.13
2	Define fins or extended surfaces	Understand	CO 4	AME014.10
3	Write the basic equation of heat transfer.	Understand	CO 4	AME014.11
4	Specify the applications of heat transfer problems.	Understand	CO 4	AME014.10
5	What is conduction of heat transfer?	Remember	CO 4	AME014.13
6	What is Newton’s law of cooling?	Understand	CO 4	AME014.10
7	Differentiate between convection and radiation heat transfer.	Remember	CO 4	AME014.10
8	Narrate the laws of heat transfer.	Understand	CO 4	AME014.10
9	Define the terms thermal conductivity and convection heat transfer coefficient.	Understand	CO 4	AME014.13
10	Analyze the heat transfer characteristics of fins.	Remember	CO 4	AME014.10
	PART – B (LONG ANSWER QUESTIONS)			
1	Derive thermal stiffness matrix for one dimensional heat conduction with lateral surface convection and with internal heat generation.	Remember	CO 4	AME014.11
2	Describe heat transfer analysis for composite wall.	Understand	CO 4	AME014.10
3	What are different types of boundary conditions for 1D heat conduction problems?	Understand	CO 4	AME014.13
4	Consider a brick wall of thickness L=30 cm, k=0.7 W/m^{0}C. The inner surface is at 28^{0}C and the outer surface is exposed to cold air at -15^{0}C. The heat transfer coefficient associated with the outside surface is h=40 W/m^{20}C. Determine the steady state temperature distribution within the wall and also the heat flux through the wall.	Understand	CO 4	AME014.11
5	Derive the finite element equation for straight fin.	Understand	CO 4	AME014.13

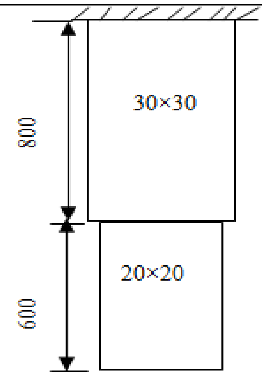
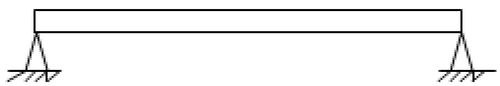
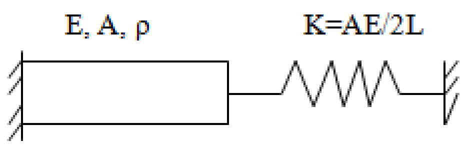
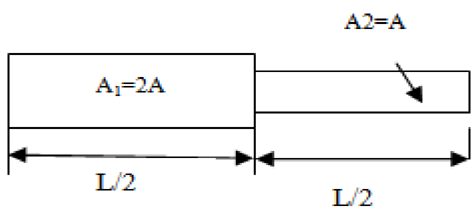
6	Refer to figure the outside of a heating tape is insulated while the inside is attached to one face of a 2 cm thick stainless steel plate (k=16.6 W/m^{0}C). The other face of the plate is exposed to the surroundings which are at a temperature of 20^{0}C. Heat is supplied at a rate of 500W/m^2. Determine the temperature of the face to which the temperature tape is attached.	Understand	CO 4	AME014.10
7	Calculate the temperature distribution in the stainless steel fin of circular cross section length 10 cm shown in figure. The cross section of the fin is circular with diameter of 2 cm. Discretize the fin into 5 elements. 	Understand	CO 4	AME014.13
8	A furnace wall is made up of three layers, inside layer with thermal conductivity 8.5 W/mK, the middle layer with conductivity 0.25 W/mK the outer layer with conductivity 0.08 W/mK. The respective thicknesses of the inner, middle and outer layer are 25 cm, 5 cm and 3 cm respectively. The inside temperature of the wall is 600^{0}C and the outside of the wall is exposed to atmospheric air at 30^{0}C with heat transfer coefficient of 45 W/m^{2}K. Determine the nodal temperatures.	Understand	CO 4	AME014.11
9	Explain the methodology for the treatment of all three boundary conditions in a 1-D heat transfer element?	Remember	CO 4	AME014.11
10	Derive one dimensional steady state heat conduction equation and apply to one dimensional fin problem	Understand	CO 4	AME014.13
	PART – C (PROBLEM SOLVING AND CRITICAL THINKING)			
1	Determine the temperature distribution through the composite wall shown in figure, when convection heat loss occurs on the left surface. Assume unit area. Assume wall thickness t_1 = 4cm, t_2 = 2cm, k_1 = 0.5w/cm^{0}c, k_2 = 0.05w/cm^{0}c, h= 0.1w/cm$^{2\,0}$c and T_α= -5^{0}c. 	Understand	CO 4	AME014.10
2	The plane wall shown in fig. The thermal conductivity K = 25W/m^{0}c and there is a uniform generation of heat in the wall of Q = 400W/m^3. Determine the temperature distribution at five nodes (include two sides of the walls) in equal distances through the wall thickness. 	Remember	CO 4	AME014.13
3	Determine the nodal temperature in a composite wall, the wall is maintained at 100 deg c at the left face and convection mode of heat transfer occurs between the right face and existing fluid	Understand	CO 4	AME014.10

	.take k_1=0.06w/cm deg c and k_2=0.2w/cm deg c. convection co efficient of heat transfer between walls and fluid h=0.1w/cm^2 ^{0}C and T_∞=25^{0}C. Consider unit area=1 cm^2 perpendicular to the direction of heat flow.			
4	A metallic fin with thermal conductivity K=360W/m^{0}c, 1mm thick and100mm long extends from a plane wall whose temperature is 235^{0}c. Determine the distribution and amount of heat transferred from the fin to air at 20^{0}c with h= 9W/m^{20}c take width of the fin is 1000 mm. Assume tip is insulted.  	Remember	CO 4	AME014.13
5	Calculate the temperature distribution in a one-dimensional fin with the physical properties k = 3 W/ cm ^{0}C, h = 0.1 W/cm^2 ^{0}C, T_∞ = 20^{0}C. the fin is rectangular in shape and is 8 cm long, 4 cm wide and 1 cm thick. Assume that convection heat loss occurs from the end of the fin.  	Remember	CO 4	AME014.10
6	A metallic fin 0.15 cm thick and 12 cm long is attached to a furnace whose wall temperature is 2200C. If the thermal conductivity of the material of the fin is 350 W/m^{0}C and convection coefficient is 9 W/m^2 ^{0}C, determine the temperature distribution if the width of the fin is 2 cm. Assume that the tip of the fin is open to the atmosphere and that the ambient temperature is 25^{0}C.	Understand	CO 4	AME014.13
7	Derive the conductivity matrix and thermal load vector for the one-dimensional finite element for the three boundary conditions.	Understand	CO 4	AME014.10
8	Heat is entering into a large plate at the rate of q_0 = -300 W/m^2. The plate is 25 mm thick. The outside surface of the plate is maintained at a temperature of 10^{0}C. Using two finite elements solve for the vector of nodal temperatures T. Thermal conductivity k = 1.0 W/m^{0}C.	Remember	CO 4	AME014.1 3
9	Find the temperature at a point P (1,1.5) inside the triangular element shown with the nodal temperatures given as T_i= 40^0 C, T_j = 34^{0}C and T_k = 46^{0}C. Also determine the location of the 42^{0}C contour line for the triangular element.  	Remember	CO 4	AME014.10

10	A composite wall consists of three materials as shown in figure. The outer temperature is T_0 = 200C. Convection heat transfer takes place on the inner surface of the wall with T_∞= 8000C and h= 25 W/m^2 ^oC. Determine the temperature distribution in the wall. 	Understand	CO 4	AME014.13
11	A bar of length 10 cm with rectangular section of width 3 cm and depth 2 cm is experiencing a temperature of 90^0 C at its left end. Assuming convection over the length of bar obtain the temperature distribution along the length. Use two 1D elements with nodes at its ends and the following data k = 5 W/ cm ^{0}C, h = 0.2 W/ cm^2 ^{0}C, T_∞ = 25^0C	Understand	CO 4	AME014.13
	UNIT-V			
	DYNAMIC ANALYSIS			
	PART - A (SHORT ANSWER QUESTIONS)			
1	What is lumped mass matrix?	Understand	CO 5	AME014.14
2	What is consistent mass matrix?	Understand	CO 5	AME014.15
3	Write the expression for element mass matrix for a bar element?	Understand	CO 5	AME014.15
4	Define the terms vibration and natural frequency.	Remember	CO 5	AME014.14
5	Write the expression for element mass matrix for a truss element?	Understand	CO 5	AME014.15
6	What are the convergence requirements in finite element modeling?	Understand	CO 5	AME014.16
7	Write the expression for modal analysis of bar and beam elements.	Understand	CO 5	AME014.14
8	Give some practical problems associated with finite element modelling.	Understand	CO 5	AME014.14
9	Write the expression for element mass matrix for a CST element?	Understand	CO 5	AME014.14
10	List out factors influencing the accuracy of the results	Understand	CO 5	AME014.16
	PART - B (LONG ANSWER QUESTIONS)			
1	Derive element mass matrix for one dimensional bar element	Remember	CO 5	AME014.14
2	Determine the approximate first two natural frequeneves of a simply supported beam using on a element. Flexural Rigidity =EI; Density = Ƥ Cross-sectional area=A	Remember	CO 5	AME014.14

				
3	Distinguish between consistent mass matrix and lumped mass matrices	Understand	CO 5	AME014.14
4	Derive the elemental mass matrix for 1-D bar element and 1-D plane truss element.	Understand	CO 5	AME014.14
5	State the properties of Eigen Values. Determine the eigen values and the associated Eigen vectors of the matrix [A] given by $$A = \begin{bmatrix} 3 & 4 \\ 4 & -3 \end{bmatrix}$$	Remember	CO 5	AME014.15
6	Explain Lumped parameter model and Continuous system model with examples.	Understand	CO 5	AME014.14
7	Determine the mass matrix for truss element with an example.	Understand	CO 5	AME014.14
8	Obtain the natural frequency of flexural vibration of a fixed beam of uniform cross-section. Use two element idealization. 	Understand	CO 5	AME014.15
9	Develop the equation of motion using Lagrange equation.	Understand	CO 5	AME014.14
10	Determine the first natural frequency of longitudinal vibration of a bar fixed at one end using two linear elements.	Remember	CO 5	AME014.14
	PART – C (PROBLEM SOLVING AND CRITICAL THINKING)			
1	Consider axial vibration of the steel bar shown in figure below. Develop the global stiffness mass matrix and determine the natural frequencies and mode shapes using the characteristic polynomial technique. 	Understand	CO 5	AME014.14
2	Evaluate the lowest Eigen value and the corresponding Eigen mode for the beam shown in Figure below 	Remember	CO 5	AME014.15
3	Determine the Eigen values and Eigen vectors for the stepped bar shown in Figure below.	Understand	CO 5	AME014.14

				
4	Consider axial vibration of the Aluminium bar shown in Figure below, develop the global stiffness and determine the nodal displacements and stresses using elimination approach and with help of linear and quadratic shape function concept. Assume Young's Modulus E = 70Gpa. 	Understand	CO 5	AME014.14
5	Find the natural frequencies in the vibration of two element simply supported beam having the parameters as length L= 2m, area of cross section A = 30 cm^2, moment of inertia I=400 mm^4 density ρ = 7800 kg/m^3 and Young's modulus E = 200 GPa.	Remember	CO 5	AME014.14
6	Consider the axial vibrations of a steel bar shown in the figure a) Develop global stiffness and mass matrices, b) Determine the natural frequencies? 	Understand	CO 5	AME014.15
7	Determine the first two natural frequencies of longitudinal vibration of the stepped bar shown in figure and plot the mode shapes. All the dimensions are in mm E = 200 GPa and ρ = 0.78 kg/cc. what will be the effect on natural frequencies if a concentrated mass of 100 kg is added to the tip of bar?	Understand	CO 5	AME014.15

				
8	Consider a simply supported beam which is discretized into 2 elements as shown in figure. Obtain the natural frequencies. The following data for beam is length=2m, area of cross section A=30 cm^2, moment of inertia I = 400mm^4, mass density ρ = 7800 kg/m^3. 	Understand	CO 5	AME014.15
9	Determine the natural frequencies of the system in figure. Consider at least two elements. 	Understand	CO 5	AME014.14
10	Find the natural frequencies of longitudinal vibration of the unconstrained stepped bar shown in figure 	Remember	CO 5	AME014.14

Prepared by:

V. Prasanna, Assistant Professor

HOD, ME